The Metric of Parallel Universe

Mohammad Hadi Mohammadi *Department of Physics , Faculty of Science , Bu-Ali Sina University, Hamedan, Iran

February 11, 2023

Abstract

In this paper, I vividly illustrated how to obtain an equation to describe a parallel universe with our universe parameters such as velocity, speed of light, scale factor, and so forth. I did this work by theoretical methods. Moreover, I used the Robertson-Walker metric and metric definition to achieve an equation that is the metric for a parallel universe. Finally, I found 10 connecting points between the two universes. I assumed three hypotheses for this scientific project.

1 Introduction

The theory of relativity successfully explains The universe in late-time expansion with the four dimensions that Robertson- walker metric truly elucidates. In the first place, Minkowski geometrize the theory of relativity and defined the time dimension. Also, he used differential geometry and utilized a metric that described a universe with four dimensions it had three spatial dimensions, and one dimension of time. In this paper, I used the theory of relativity structure, and three hypotheses to describe a parallel universe. Furthermore, we can analyze a parallel universe with data from our universe. I mean, we can calculate the expansion rate and acceleration of another universe with ours.

2 The first hypothesis

I assume that all the parallel universes have been started in the same point. I mean, all the universes have been mixed to gather, and the started point and endpoint are the same. There is a possibility that we can see these parallel universes by going to black holes.

3 The second hypothesis

The speed of light is constant and equal in all parallel universes.

*Emai:hadi.symbol@gmail.com

4 The third hypothesis

Elapsing time is the same for all the universes Hence, we can write the following equation for two universes:

$$c^2dt^2 = \gamma^2 ds_2^2 + \eta^2 ds_1^2 \tag{1}$$

γ, η could be functions of time and space, and ds_1^2 is the metric of our universe that we can describe with Robertson- Walker metric and ds_2^2 is a parallel universe. The metric is as follows:

$$ds_1^2 = c^2dt^2 - \alpha^2 d\Sigma^2 \tag{2}$$

5 Mathematical Method application to obtain the metric of a parallel universe

Based equation (1) and (2) we can write down :

$$\begin{array}{l} c = dt\sqrt{(\gamma^2 \frac{ds_2^2}{dt^2} + \eta^2 \frac{ds_1^2}{dt^2})} \\ cdt = dt\sqrt{(\gamma^2 \frac{ds_2^2}{dt^2} + \eta^2 \frac{ds_1^2}{dt^2})} \\ ds_1^2 = c^2dt^2 - \alpha^2 d\Sigma^2 \\ \frac{ds_1^2}{dt^2} = c^2 - \alpha^2 \frac{d\Sigma^2}{dt^2} \\ cdt = dt\sqrt{(\gamma^2 \frac{ds_2^2}{dt^2} + c^2\eta^2 - \eta^2\alpha^2 \frac{d\Sigma^2}{dt^2})} \\ cdt = dt\sqrt{(\gamma^2 \frac{ds_2^2}{dt^2} + \eta^2 c^2(1 - \alpha^2 \frac{d\Sigma^2}{c^2dt^2}))} \\ cdt = dt\sqrt{(\gamma^2 \frac{ds_2^2}{dt^2} + \eta^2 c^2(1 - \frac{\alpha^2 V_\Sigma^2}{c^2}))} \\ c^2 = (\gamma^2 \frac{ds_2^2}{dt^2} + \eta^2 c^2(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})) \end{array} \tag{3}$$

Then, we divide c^2;thus,the equation is as follows:

$$1 = (\gamma^2 \frac{ds_2^2}{c^2dt^2} + \eta^2(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})) \rightarrow ds_2^2 = \frac{\eta^2}{\gamma^2 c^2}(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})dt^2 \tag{4}$$

Based equation (1):

$$\gamma^2 = c^2 \frac{dt^2}{ds_2^2} - \eta^2 \frac{ds_1^2}{ds_2^2} \tag{5}$$

I apply (4)in (5); thus, we have:

$$\begin{aligned}
&\gamma^2 = c^2\left(\frac{\gamma^2 c^2}{\eta^2(1-\frac{\alpha^2 V_\Sigma^2}{c^2})}\right) - \eta^2 \frac{ds_1^2}{ds_2^2}\\
&\gamma^2\left(1 - \frac{c^4}{\eta^2(1-\frac{\alpha^2 V_\Sigma^2}{c^2})}\right) = -\eta^2 \frac{ds_1^2}{ds_2^2}\\
&c^2dt^2 = \gamma^2 ds_2^2 + \eta^2 ds_1^2 \rightarrow ds_2^2 = \frac{c^2dt^2 - \eta^2 ds_1^2}{\gamma^2}\\
&\frac{ds_1^2}{ds_2^2} = \vartheta^2 \rightarrow \vartheta^2 = \frac{c^2dt^2-\alpha^2 d\Sigma^2}{\frac{c^2dt^2-\eta^2 ds_1^2}{\gamma^2}} \rightarrow \vartheta^2 = \frac{\gamma^2 c^2 dt^2 - \gamma^2\alpha^2 d\Sigma^2}{(1-\eta^2)c^2dt^2+\eta^2\alpha^2 d\Sigma^2}\\
&\gamma^2\left(1 - \frac{c^4}{\eta^2(1-\frac{\alpha^2 V_\Sigma^2}{c^2})}\right) = -\eta^2 \frac{\gamma^2 c^2 dt^2 - \gamma^2\alpha^2 d\Sigma^2}{(1-\eta^2)c^2dt^2+\eta^2\alpha^2 d\Sigma^2}\\
&\left(1 - \frac{c^4}{\eta^2(1-\frac{\alpha^2 V_\Sigma^2}{c^2})}\right) = -\eta^2 \frac{c^2 dt^2 - \alpha^2 d\Sigma^2}{(1-\eta^2)c^2dt^2+\eta^2\alpha^2 d\Sigma^2}\\
&\left(1 - \frac{c^4}{\eta^2(1-\frac{\alpha^2 V_\Sigma^2}{c^2})}\right) = -\eta^2 \frac{c^2 dt^2 - \alpha^2 d\Sigma^2}{(1-\eta^2)c^2dt^2+\eta^2\alpha^2 d\Sigma^2} \rightarrow \frac{c^4(1-\eta^2)c^2dt^2}{(1-\frac{\alpha^2 V_\Sigma^2}{c^2})} = \eta^2 c^2 dt^2 + \alpha^2 d\Sigma^2
\end{aligned} \tag{6}$$

We divide dt^2

$$\frac{(1-\eta^2)c^6}{(1-\frac{\alpha^2 V_\Sigma^2}{c^2})} = \eta^2 c^2 + \alpha^2 V_\Sigma^2 \tag{7}$$

$$\begin{aligned}
&(1-\frac{\alpha^2 V_\Sigma^2}{c^2})\eta^2 c^2 + \alpha^2 V_\Sigma^2(1-\frac{\alpha^2 V_\Sigma^2}{c^2}) = c^6 - \eta^2 c^6\\
&(1-\frac{\alpha^2 V_\Sigma^2}{c^2})\eta^2 c^2 + \eta^2 c^6 = c^6 - \alpha^2 V_\Sigma^2(1-\frac{\alpha^2 V_\Sigma^2}{c^2})\\
&\eta^2((1-\frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6) = c^6 - \alpha^2 V_\Sigma^2(1-\frac{\alpha^2 V_\Sigma^2}{c^2})\\
&\eta^2 = \frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1-\frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6}
\end{aligned} \tag{8}$$

Now we come back to the equation (1)

$$c^2dt^2 = \gamma^2 ds_2^2 + \eta^2 ds_1^2 = \gamma^2 ds_2^2 + \left(\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1-\frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6}\right)(c^2dt^2 - \alpha^2 d\Sigma^2) \tag{9}$$

The metric of equation (1) is as follows:

$$\tilde{g}(X) = \begin{pmatrix} \gamma^2 & 0 \\ 0 & \eta^2 \end{pmatrix} \tag{10}$$

Based the general theory of relativity, there is an equation for determinant of the metric that is as follows:

$$\begin{aligned}
&\nabla_0(\sqrt{-\tilde{g}}) = 0\\
&\nabla_0(\sqrt{-\gamma^2\eta^2}) = 0\\
&\frac{-\gamma\dot{\gamma}\eta^2 - \eta\dot{\eta}\gamma^2}{\sqrt{-\gamma^2\eta^2}} = 0\\
&\gamma\dot{\gamma}\eta^2 + \eta\dot{\eta}\gamma^2 = 0\\
&\gamma d\gamma\eta^2 + \eta d\eta\gamma^2 = 0\\
&\frac{1}{\gamma}d\gamma + \frac{1}{\eta}d\eta = 0\\
&\ln\gamma = -\ln\eta \rightarrow \gamma \equiv \frac{1}{\eta}
\end{aligned} \tag{11}$$

Now we have all the coefficients in(1).

$$c^2dt^2 = \frac{(1-\frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6}{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}} ds_2^2 + \left(\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1-\frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6}\right)(c^2dt^2 - \alpha^2 d\Sigma^2) \tag{12}$$

Finally, we can describe the metric of a parallel universe with the Robertson-Walker metric :

$$ds_2^2 = (\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6})c^2dt^2 - (\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6})^2(c^2dt^2 - \alpha^2 d\Sigma^2) \tag{13}$$

6 Connecting points between the two universes

The parallel universe metric is the function of our universe metic. The assumption I applied in this research is that the time dimension exists in the parallel universe as do we. Now we put together the metric of parallel universe and the metric of our universe to find out the connecting points between universes; therefore, we have as follows:

$$ds_2^2 = ds_1^2 \tag{14}$$

$$(\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6})c^2dt^2 - (\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6})^2(c^2dt^2 - \alpha^2 d\Sigma^2) = c^2dt^2 - \alpha^2 d\Sigma^2 \tag{15}$$

$$/c^2dt^2$$

$$\begin{aligned}
&(\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6}) - (\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6})^2(1 - \alpha^2 \frac{V_\Sigma^2}{c^2}) = 1 - \alpha^2 \frac{V_\Sigma^2}{c^2} \\
&(\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6}) - (\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6})^2 - \alpha^2 \frac{V_\Sigma^2}{c^2}(\frac{c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}}{(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6})^2 = 1 - \alpha^2 \frac{V_\Sigma^2}{c^2}
\end{aligned} \tag{16}$$

I multiply this ([((1 − $\frac{\alpha^2 V_\Sigma^2}{c^2}$)$c^2 + c^6$)^2)to the equation above:

$$\begin{aligned}
&(1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6)(c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2}) - (c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2})^2 + \\
&-\alpha^2 \frac{V_\Sigma^2}{c^2}(c^6 - \alpha^2 V_\Sigma^2 + \frac{\alpha^4 V_\Sigma^4}{c^2})^2 = (1 - \alpha^2 \frac{V_\Sigma^2}{c^2})((1 - \frac{\alpha^2 V_\Sigma^2}{c^2})c^2 + c^6)^2
\end{aligned} \tag{17}$$

For simplicity of calculation, I consider c=1

$$(1 - \alpha^2 V_\Sigma^2 + \alpha^4 V_\Sigma^4)^2 = 1 + 3\alpha^4 V_\Sigma^4 - 2\alpha^2 V_\Sigma^2 - 2\alpha^6 V_\Sigma^6 + \alpha^8 V_\Sigma^8 \tag{18}$$

$$\begin{aligned}
&(2 - \alpha^2 V_\Sigma^2)(1 - \alpha^2 V_\Sigma^2 + \alpha^4 V_\Sigma^4) - (1 - \alpha^2 V_\Sigma^2 + \alpha^4 V_\Sigma^4)^2 + \\
&-\alpha^2 V_\Sigma^2 (1 - \alpha^2 V_\Sigma^2 + \alpha^4 V_\Sigma^4)^2 = (1 - \alpha^2 V_\Sigma^2)(2 - \alpha^2 V_\Sigma^2)^2
\end{aligned} \tag{19}$$

$$\begin{aligned}
&2 - 2\alpha^2 V_\Sigma^2 + 2\alpha^4 V_\Sigma^4 - \alpha^2 V_\Sigma^2 + \alpha^4 V_\Sigma^4 + \\
&-\alpha^6 V_\Sigma^6 - 1 - 3\alpha^4 V_\Sigma^4 + 2\alpha^2 V_\Sigma^2 + \\
&+2\alpha^6 V_\Sigma^6 - \alpha^8 V_\Sigma^8 - \alpha^2 V_\Sigma^2 - 3\alpha^6 V_\Sigma^6 + \\
&+2\alpha^4 V_\Sigma^4 + 2\alpha^8 V_\Sigma^8 - \alpha^{10} V_\Sigma^{10} = (1 - \alpha^2 V_\Sigma^2)(2 - \alpha^2 V_\Sigma^2)^2
\end{aligned} \tag{20}$$

Finally, we have the 10th-degree polynomial equation:

$$6\alpha^2 V_\Sigma^2 - \alpha^8 V_\Sigma^8 - \alpha^6 V_\Sigma^6 - 3\alpha^4 V_\Sigma^4 + 2\alpha^8 V_\Sigma^8 - \alpha^{10} V_\Sigma^{10} - 3 = 0 \tag{21}$$

As you can see, this equation expresses to us that there are 10 connecting points between the two universes.
For example, one of the answers is $\alpha_1 V_{1\Sigma} = C_1$ Also, since we are in the dark energy-dominated era, the scale factor is as follows:

$$\alpha = \exp(-H_0 t) \tag{22}$$

; thus,

$$\begin{array}{l} \alpha_1 V_{1\Sigma} = C_1 \\ r = \Sigma \\ \alpha_1 V_{1\Sigma} = C_1 \\ \exp(-H_0 t)\frac{dr}{dt} = C_1 \\ r_1 = C_1 \int \frac{dt}{e^{-H_0 t}} \end{array} \tag{23}$$

$$V_\Sigma^2 = \frac{d\Sigma^2}{dt^2} \tag{24}$$

If we detect a window in the determined distance , we can certainly say this parallel universe exists.

7 Conclusion

As we understood there is a weird relationship between our universe and the parallel universe. By using equation (13) into the Einstein field equation:

$$G_{\mu\upsilon} + \Lambda g_{\mu\upsilon} = \frac{8\pi G}{c^4} T_{\mu\upsilon} \tag{25}$$

We can calculate the acceleration and Hubble parameter of the parallel universe. Moreover, we can calculate the Friedmann equations in the new universe. Finally I found the connecting points.If we detect a window in the determined distance , we can certainly say this parallel universe exists.

References

[1] Professor Steven Weinberg,Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, *John Wiley & Sons, Inc.* 1 edition (July 1972),ISBN-13: 978-0471925675